squared paper on which the divisions are thirds of the unit, so that a boy will have it fixed in his mind that $3\frac{1}{3}$ is exactly $\log_2 10$.

My intention was to give a good exercise on the use of squared paper for interpolation; it happens to be a method of calculating logarithms correctly to as many places as we please. It keeps before a boy the simple notion that a common logarithm is the index of a power of 10. The idea before Mr. Dufton's pupil is much more complex, and he is not likely to find the logarithm of any number correct even to the second figure.

February 19. JOHN PERRY.

RECENT PROGRESS IN PHOTOGRAPHY.

THE progress of knowledge and of skill in its application is often so gradual that although there may be a vast difference between the condition of affairs a few years ago and at the present time, it may be impossible to discover definite steps in the general forward movement. And after a few specific cases of undoubted progress have been singled out, it may be that they, or some of them, will subsequently prove to be only side issues of comparatively trivial importance. On the other hand, a circumstance that is quite obvious to the scientific student may be worked upon by a commercial firm and so advertised that a method of work becomes largely modified, and a practical advance effected without any addition to our knowledge.

It has been known from the earliest of photographic times that sensitive surfaces require a certain minimum of exposure before any change in them can be detected. But the abolition of so-called dark rooms for printing by development, and the employment of the same light for development as for exposure, was a possibility almost neglected until the American "Velox" paper was introduced. Of course, for exposure the printing-frame is held very near to the light, and during development the print is shaded. This method of work may be only a passing fashion, but it has revolutionised the printing arrangements of many an amateur, and been so appreciated that several firms have put slow papers and lantern plates on the market for working in the same manner, and other makers are seriously discussing whether it is desirable to do so.

A modification of pigment printing that has recently been introduced by Mr. Thomas Manly constitutes a more substantial advance, though whether it will be so widely appreciated as the silver papers slow enough for development in gas-light remains to be seen. He calls his process "Ozotype." So far as concerns important and serious work, a small improvement in either carbon or platinum printing is likely to be of more real value than any possible change in silver printing. But Mr. Manly's is not a mere modification of detail. Putting it simply, he exposes the transfer paper instead of the pigmented tissue under the negative, and thus by one transfer he gets a print that is not laterally inverted, a result which requires a double transfer by the ordinary method, or else the making of a special inverted negative for single transfer. As the paper exposed is not pigmented, the progress of printing can be judged of by inspection, and there are other advantages of a less important character, such as the absence of any need for "safe edges" to the negatives. The paper that is exposed under the negative is made sensitive by means of a mixture of potassium dichromate and a manganous salt. On exposure, the chromate is reduced and the manganese is thereby oxidised, and both products of the change are insoluble in water. By washing, an image that has oxidising powers is obtained, and this may be utilised in many ways. It does not seem to deteriorate by keeping. To pigment the image, a piece of carbon tissue is soaked in a weak solution containing acetic acid, hydroquinone, and ferrous sulphate, squeegeed on to the print and allowed to dry. Development is effected as usual in carbon printing. Mr. Manly supposes that the acetic acid causes the manganic compound to reoxidise the chromic compound to a soluble salt (chromate?) which is absorbed by the gelatine of the tissue. In the gelatine the hydroquinone reduces the chromium compound to the chromic condition, which, as usual, renders the gelatine insoluble. This appears to be the inventor's working theory. Final practical details are not yet published, but it is certain that the process is capable of yielding good and useful results.

The toning of prints in which the image consists of metallic silver by causing it to act on the solution of the ferricyanide of a metal, reducing it, and thereby causing the deposition of the corresponding ferrocyanide on the image, is a method that has long been known. The ferrocyanide of copper, being of a reddish-brown colour, is a desirable toning material, but copper ferricyanide is not soluble in water, and the various solvents hitherto employed have not given satisfaction. Mr. W. B. Ferguson has just shown that a solution of potassium citrate is a solvent for the ferricyanide that serves perfectly, and has thus converted an almost useless process into one that is easy and certain. The colour appears to be rather browner than that yielded by the corresponding uranium process, and it is hoped that the colouring matter will prove more permanent.

There have recently been quite a number of new introductions that affect the production of negatives. Foremost among these stand the rapid "spectrum plates" of Cadett and Neall, and the colour screens adjusted thereto by Mr. Sanger Shepherd. Red sensitive plates have been made before, but the even sensitiveness throughout the spectrum that these plates show, has never, in our experience, been equalled. But no plate will of itself render the various colours according to their proportional visual brightness. The sensitiveness to blue and violet vastly preponderates in all cases, and in order to reduce this light and so compensate for the excessive sensitiveness thereto, various coloured screens have been in use. For general purposes, this screening has been done by the roughest of methods, whether yellow glass or dyed films have been used. But Mr. Sanger Shepherd has prepared screens that are adjusted to the plates within a small margin of error, using for the testing the method of colour sensitometry introduced by Sir William Abney. With such an adjusted colour screen and plate a coloured object can be photographed in almost any light so that the print will give the correct comparative luminosities of all the colours as they appear under the conditions when photographed. The chief exception is that light of less refrangibility than the solar line C, or about that, is not represented, this small portion of the less refrangible red being reserved as a light useful when making the plates and working with them. Colour screens are provided for dark-room lights, that transmit only the least refrangible red, far enough from where the practical sensitiveness of the plates begin to furnish a light that is quite unable to harm the plates under the usual conditions of development, &c. Mr. Sanger Shepherd also prepares colour screens for spectrum plates adapted for the three-colour process of reproduction, and as they are adjusted by measurement and to the same plate, this is a considerable step towards the simplification of work and the ensuring of correct results.

Some new intensifiers for negatives have recently been suggested, but as their effects have not been thoroughly investigated, they should not replace the use of mercuric chloride followed by ferrous oxalate, which is the only method that has yet been shown to give a definite result equally proportioned over the whole negative. Ammonium persulphate, as a reducer, has been shown to thin the image to a nearly equally proportioned degree all

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over, instead of removing a larger proportion of the thinner parts of the image, which, of course, lie near the surface of the film. This is an exceedingly useful effect; but here again the chemical changes have not been investigated, and the theories that have been suggested to account for the exceptional effect are far from satisfactory. It is not certain, indeed, that the remaining image is of pure silver.

The makers of apparatus are always seeking to improve their goods, and they are, as a rule, so successful that it is impossible to refer here to other than the most important advances. Photographers used to be satisfied with lenses that either covered a large field in proportion to their focal length, or that had a large aperture; but these properties that used to be considered incompatible now have to be combined; a large angle of view is maintained while the aperture is increased. Instead of *f*/8, which used to be regarded as the maximum aperture for outdoor work, we now have *f*/6, and even larger apertures, without the introduction of the peculiar faults usually associated with portrait lenses. The firm of Goerz, of Berlin, has quite lately put upon the market a doublet, each combination of which consists of five elements, the complete objective having an aperture of *f*/5·5. These—the stigmatics of Dallmeyer at *f*/4 and *f*/6, the planars of Zeiss with apertures of about *f*/4, and other lenses of similar properties—are instruments of precision for giving an image over an extended field, as telescope objectives are instruments of precision for giving definition over a very small field. In conjunction with the rapid gelatine plates of to-day, they place a power in the hands of scientific workers that was not conceived possible a few years ago.

The firm of Dallmeyer have recently improved their stigmatics, series *f*/6, by putting the combination of greater focal length in the front instead of behind. To use either combination alone, it is now only necessary to remove the other, and the extension of camera necessary is nearly the same for both the combinations, although their equivalent focal lengths are approximately as 1·5 to 2, taking the focal length of the whole combination as the unit. Dr. Rudolph, of Zeiss', has investigated the question of the use of cylindrical surfaces in objectives for the purpose of getting a different ratio of enlargement (or reduction) in two directions at right angles to each other. One result of this work is the "anamorphot" issued by Messrs. Zeiss, and its use is chiefly, if not exclusively, in the readjustment of the proportion of length to breadth of designs for their application in the decorative arts.

There does not appear to have been any radical improvement in cameras of late; but the system of cinematography, made possible by the perfection to which film-supported sensitive surfaces have been brought, continues to engage the attention of a large number of inventors. The most recent, and doubtless most interesting, application of this principle is in an apparatus that the Kodak Company are making for Sir Norman Lockyer, for use during eclipses of the sun. The apparatus will accommodate a film five inches wide and of length suitable for the required series of exposures. The opening behind which the film is exposed is twelve inches long and three inches wide. The apparatus is designed to photograph a series of spectra, as of the chromosphere, so that the exposures may follow each other with greater rapidity and certainty than is possible when plate-changing has to be done by hand. The operator has only to turn a handle continuously, and at each complete revolution an exposure is made, the exposed film is wound up, and a new portion brought into position. Three-quarters of the revolution effects the change of film; at the beginning of the remaining fourth the shutter is opened; it continues open until the revolution is completed, or nearly completed, when it is closed; then the film-changing takes place again, and so on. By stopping the crank during the last quarter of the revolution, a time-exposure of any duration may be given. It is expected that the apparatus will be used in conjunction with a twenty-foot objective of six inches aperture with a prism in front of the objective; and as this lens gives practically no curvature on a field twelve inches in length, the film will be used flat.

Scientific photographers on the Continent have lately been paying more attention to the measurement of the opacities of photographic plates. Dr. J. Hartmann, of Potsdam, has recently described an apparatus constructed for him for comparing opacities. It consists of a horizontal microscope with its ocular and objective, with a tube branching from it at right angles, downwards, that carries a second objective. At the junction of the two tubes is the well-known arrangement of two right-angled prisms, with their hypothenuse surfaces cemented together except at a small disc in the centre of the adjacent sides; so that one sees a small portion of the plate being tested surrounded by the comparison tint. The apparatus appears to be unnecessarily costly and complicated when compared with apparatuses that have been used in this country for a similar purpose.

There are many other matters that would claim attention in a complete *résumé* of recent progress in photography, some of which have already been referred to in these columns.

C. J.

THE POSITION THAT UNIVERSITIES SHOULD TAKE IN REGARD TO INVESTIGATION.

THE American Society of Naturalists arranged for a discussion on the duties of universities with regard to investigation, and the American journal, *Science*, has recently published the contributions to the discussion made in the end of last year at the New Haven meeting. Profs. Dwight of Harvard, Chittenden of Yale, Jastrow of Wisconsin, Patten of Dartmouth, and Dr. Macdougal of the New York Botanic Gardens—five distinguished representatives of the natural sciences in America—made a formal and deliberate expression of their opinions, and an examination of these convictions cannot fail to be valuable to English readers. On all salient points these experts are in complete agreement. They have no doubt that the connection between universities and research is fundamental. Dr. Macdougal dismisses it as "axiomatic." Prof. Jastrow declares that a university should be the "natural habitat" of investigation. Prof. Dwight is "sure of a sympathetic hearing from public and universities for discussion of the modes and conditions of university research." The others differ only in the precise phraseology they employ. Nor is there any doubt but that university teachers should be investigators by temperament and habit. As Prof. Chittenden insists, the primary function of a university is a diffusion of the knowledge already gained, rather than the provision of new knowledge; but, although teachers who were not investigators have existed, the ideal teacher must be more than a diffuser. All universities of standing make success in investigation a necessary qualification for their teachers, and, in effect, our witnesses all agree that, having chosen rightly such men, it is the duty of the universities to see that time and opportunity for investigation should be found for them during their tenure of office.

There is a certain divergence of opinion as to the extent to which original investigation should be made an actual part of the training of students. Prof. Dwight and Prof. Patten are not inclined to encourage it, the former thinking chiefly of medical students and agreeing with Huxley, that whoever adds one tittle of what is unnecessary to medical education is guilty of a very grave

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